Targeting Early Antecedents to Prevent Tobacco Smoking: Findings From an Epidemiologically Based Randomized Field Trial

Sheppard G. Kellam, MD, and James C. Anthony, PhD

ABSTRACT

Objectives. This study examined whether interventions aimed at aggressive/disruptive classroom behavior and poor academic achievement would reduce the incidence of initiation of smoking.

Methods. An epidemiologically based, universal randomized preventive trial involved 2311 children in 2 classroom-based preventive interventions or controls. Each intervention was directed at 1 of the aforementioned 2 antecedents over first and second grades in 19 urban schools.

Results. Smoking initiation was reduced in both cohorts for boys assigned to the behavioral intervention.

Conclusions. Targeting early risk antecedents such as aggressive behavior appears to be an important smoking prevention strategy. (*Am J Public Health.* 1998;88:1490–1495)

Thousands of young people start smoking every day; an estimated one third will become tobacco dependent.[1] One way to prevent this may be to change early antecedents of smoking identified through developmental epidemiological studies.[2–4] Among boys especially, aggressive/disruptive classroom behavior (in the form of breaking rules and fighting), as early as first grade, has been found repeatedly to predict later tobacco and other heavy drug use, as well as antisocial behavior and criminality.[5–12] Poor academic achievement, found to be correlated early on with aggressive behavior, has been shown to predict depression and, in some studies, drug use.[8,9,13–16] In this study, 2 classroom-based interventions were each directed at 1 of these 2 early antecedents. We sought to test whether either intervention would reduce the incidence of initiating tobacco use, particularly among boys.

Methods

Interventions

The Good Behavior Game, a behavior management strategy designed to improve aggressive/disruptive classroom behavior, is led by the teacher during regular class periods.[16,17] After baseline assessments of target behaviors, teachers assign all students to 1 of 3 teams, balancing teams for sex and levels of aggressive behavior. The teacher defines and posts undesirable behaviors. Examples are fighting, shouting out of turn, and teasing. Teams are rewarded when no member exhibits the proscribed behaviors during game sessions. If a child misbehaves, the team loses points. At first, tangible prizes are used, such as colorful stickers and erasers. Later in the school year, teachers use less tangible rewards. At first, the game was played for 10 minutes 3 times per week during the regular curriculum, with the frequency and length of sessions increasing over first and second grades. Rewards were given weekly; if each child behaved well, all teams could win.[17,18]

Mastery Learning, an enriched curriculum, was directed at raising reading achievement scores.[17,19] Key elements were high expectations, small instructional units, use of formative testing, and individualized corrective methods. Students did not proceed to the next unit until 80% had achieved 80% to 85% of the learning objectives (instead of the usual 50%).[17,18]

These classroom-based interventions were implemented for 2 years, in the first and second grades. We have previously reported evidence of Good Behavior Game impact on aggressive/disruptive behavior through sixth grade for boys who, at baseline, were above the median in terms of aggressive behavior.[17–22] Improvements in reading scores with Mastery Learning were followed by reduced depressive symptoms over first grade, particularly among girls.[19] Raising achievement scores accounted for reduced aggressive behavior, particularly among boys.[20]

Study Population and Research Design

Five urban areas were defined with socioeconomic levels ranging from very poor to middle class.[15] In each area, 3 to 4 public elementary schools with similar socioeconomic and racial/ethnic profiles were selected. Within each area, the Good Behavior Game

The authors are with the Prevention Research Center, Department of Mental Hygiene, School of Hygiene and Public Health, Johns Hopkins University, Baltimore, Md.

Requests for reprints should be sent to Sheppard G. Kellam, MD, Prevention Research Center, Mason F. Lord Bldg, Suite 500, 5200 Eastern Ave, Baltimore MD 21224.

This article was accepted March 5, 1998.

was randomly assigned to 1 school and Mastery Learning to another; 1 or 2 schools were controls. Control classrooms received customary school programs. Within each intervention school, 1 first-grade classroom and teacher were assigned randomly to the intervention, and at least 1 classroom served as a within-school control. Within each school, all entering first graders were assigned in alphabetic sequence to classrooms. Over the 2 intervention years (first and second grades), classroom composition was kept intact. Transfers from one intervention to the other or from control to either intervention were rare, but in this study we adopted an intent to treat strategy, using initial assignment at baseline to define the intervention and control children. Protocols for this school-based investigation were approved by the Johns Hopkins School of Public Health institutional review board. Each child's parent/guardian was asked to give informed consent. During the first year of recruitment, only 5% declined to participate.[23]

Two consecutive cohorts of first-grade children were recruited (total n = 2311), 1196 in cohort 1 (1985) and 1115 in cohort 2 (1986). A few children reported starting to smoke cigarettes prior to entry into first grade. Because they no longer were at risk for initiation, these children were excluded from the analytic sample. A total of 1604 children (cohort 1, n = 818 [68%]; cohort 2, n = 786 [70%]) initially still at risk remained in the Baltimore City Public Schools and completed an assessment of tobacco and other drug experiences on at least 1 occasion after intervention from 1989 until 1994. Ten students withdrew consent for follow-up assessments.[24] When attrition occurred, it was unrelated to intervention status ($P > .25$).

Among the 1604 children, 808 were boys and 796 were girls, and more than 90% had been born in either 1979 or 1980. About 22% were assigned to Good Behavior Game classrooms (n = 352), 22% were assigned to Mastery Learning classrooms (n = 348), and the rest were assigned to control classrooms (n = 904). A total of 502 youths (31.3% of the follow-up sample) were found to have initiated tobacco smoking when last assessed (Table 1).

TABLE 1—Characteristics of Tobacco Users and Nonusers

	Tobacco Users (n = 502), No. (%)	Tobacco Nonusers (n = 1102), No. (%)	Total, No. (%)
Year of entry into 1st grade			
1985	275 (54.8)	543 (49.3)	818 (51.0)
1986	227 (45.2)	559 (50.7)	786 (49.0)
Sex			
Male	262 (52.2)	546 (49.5)	808 (50.4)
Female	240 (47.8)	556 (50.5)	796 (49.6)
Birth year			
1978	67 (13.4)	78 (7.1)	145 (9.0)
1979	230 (45.8)	511 (46.4)	741 (46.2)
1980	205 (40.8)	513 (46.5)	718 (44.8)
Design status			
Good Behavior Game	92 (18.3)	256 (23.2)	348 (21.7)
Mastery Learning	111 (22.1)	241 (21.9)	352 (21.9)
Standard setting	299 (59.6)	605 (54.9)	904 (56.4)

Assessment Procedures

At the end of the first quarter of first grade, prior to implementation of the interventions, each teacher rated each child in the classroom in a standardized 2-hour interview using the Teacher Observation of Classroom Adaptation–Revised.[25,26] This instrument's Authority Acceptance subscale gauges each child's level of aggressive/disruptive behavior and includes items such as "fights," "breaks rules," and "harms property," each rated from 1 to 6 depending on frequency. The subscale's reliability has been adequate (Cronbach $\alpha > .85$ in the studies cited here); a robust association between first-grade ratings and adolescent drug use over 10 years has been reported.[8] Research staff monitored fidelity of intervention implementation; no control classroom teachers used behavior management methods such as the Good Behavior Game or the Mastery Learning curriculum. Forty hours of instruction and support were provided to all teachers, including control classroom teachers.

Periodic meetings with school officials, community leaders, and parents led to community support for learning about children's drug experiences, but there was concern about saliva, breath, or urine testing. The accepted solution was annual face-to-face interviews 40 to 70 minutes in duration. These interviews were administered during the spring of each year from ages 8 and 9 through age 14. The interview was conducted in a private room in the school by a trained young adult interviewer. The interviewer first worked through issues of trust and rapport and read a disclosure statement that provided students with an opportunity to decline participation. The interviewer then read each standardized question and marked the student's responses. Each year, students were asked whether they had tried tobacco and their age at first use.[8,24,27]

Statistical Analysis

We used standard life table and survival analysis methods to compare risk of initiating tobacco use for 2 interventions and all internal and external control classrooms. Kaplan-Meier[28] survival curves for each group were compared via log-rank statistics as an aid to interpretation. Adjusted estimates for the relative risk of tobacco smoking also were obtained via conditional forms of Cox proportional hazards modeling; EGRET[29] was used in calculating estimates. To accommodate clustering of students within initial elementary schools, this analysis involved presorting of students into strata defined by school attended in first grade. Beyond accommodating the clustering of students, the Cox model[30] provided safeguards against the possibility that observed variations in smoking might be attributable to imbalances in the distribution of covariates (e.g., age, sex, level of aggression in first grade).

Results

Descriptive information about combined cohorts is provided in Table 1. Of the 1604 children who had not smoked at baseline, 502 had tried smoking by 14 years of age. Boys and girls were analyzed separately, considering the stronger attributable risk of aggressive behavior among boys. In each cohort, boys in Good Behavior Game classrooms were less likely than boys in control classrooms to initiate tobacco smoking (log rank $P = .03$). This was most apparent after 10 years of age. Figures 1 and 2 are plots of the male cohorts' cumulative incidence of tobacco smoking from 6 through 14 years of age. Girls in Good Behavior Game classrooms were not at lower risk (log rank $P = .55$).

Estimates from the Cox proportional hazards analyses were consistent with life table results. When grouped into risk sets defined at first-grade entry, boys in Good Behavior Game classrooms had a lower risk of starting to smoke than boys in control

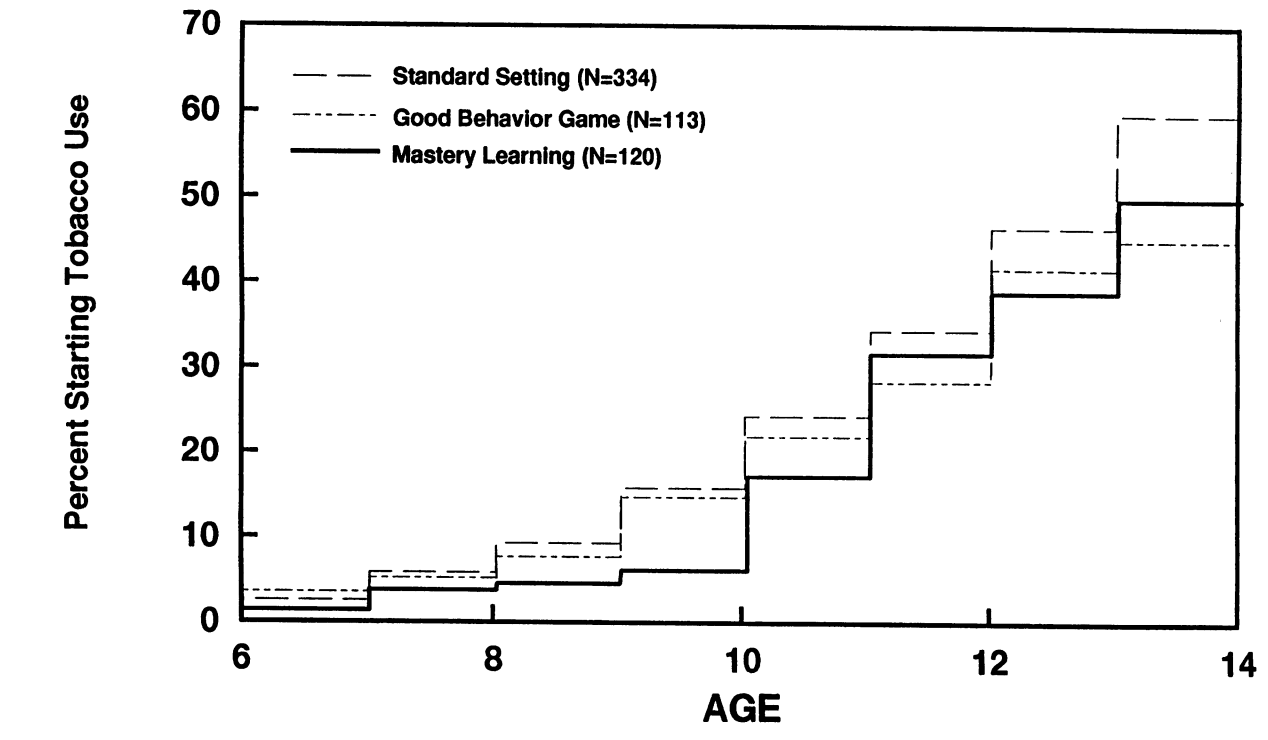

FIGURE 1—Impact of Mastery Learning and Good Behavior Game on boys in first and second grades in terms of initiation of tobacco smoking through 14 years of age: cohort 1.

classrooms (estimated relative risk [RR] = 0.62, 95% confidence interval [CI] = 0.40, 0.97; $P = .04$). The estimated risks for girls in Good Behavior Game and control classrooms were essentially the same (RR = 0.9, 95% CI = 0.57, 1.42; $P = .66$).

For girls in both cohorts, the Good Behavior Game appeared not to have affected risk of starting to smoke. In contrast, the relative risk estimates for boys in Good Behavior Game classrooms vs boys in control classrooms were 0.58 (95% CI = 0.33, 1.00) in cohort 1 and 0.62 (95% CI = 0.29, 1.31) in cohort 2. For boys in cohort 2 only, there was a statistically significant inverse association between assignment to Mastery Learning and risk of tobacco smoking (RR = 0.46, 95% CI = 0.24, 0.87; $P = .017$), although there was a similar trend in cohort 1.

In exploratory analyses of subgroup variation, both cohorts were grouped by gender and classified into tertiles by first-grade teacher's rating of aggressive/disruptive behavior; these analyses used the Cox models (Table 2). Boys in the best behaving tertile showed more impact, being much less likely to start smoking than control boys (RR = 0.13, 95% CI = 0.03, 0.62; $P = .01$). A congruent result emerged from corresponding comparative life table analyses of this subgroup of boys (log rank $P = .003$). We found no Good Behavior Game impact at any level of aggressive/disruptive behavior among girls.

Discussion

In 2 consecutive cohorts, the estimated risk of initiating tobacco use was lower than expected for boys assigned to the Good Behavior Game intervention. The lack of impact of the Good Behavior Game for girls in these classrooms is consistent with the much lower risk for later drug use associated with aggressive/disruptive classroom behavior among girls. This result also supports the importance of early risk behaviors, which occur much more frequently among boys, in the etiology of teenage tobacco use.[8,9,13–15,31]

Several caveats merit attention. First, this study focused on young people who remained in Baltimore public schools, an important and definable epidemiologic population and a majority of the original children. It did not include children who moved to other areas or transferred to private schools; these participants are now being followed up at 19 or 20 years of age. Outmigration from the school system was unrelated to intervention assignment. Second, our assessment of the youths' tobacco experiences depended on self-report interview assessments made annually. Some researchers prefer to use bioassays to limit methodological problems associated with self report. However, we found that most youths recalled their first tobacco smoking experiences clearly. Furthermore, bioassays have questionable utility for assessing tobacco smoking across spans of 1 year or more. Self-report assessments have been central in basic studies linking early ratings of aggressive/disruptive behavior to later teenage smoking.[8]

Appearance of subgroup variation in response to interventions deserves attention, as discussed recently by Hatch.[32] We have already commented on gender differences. We also found that boys at lower levels of aggressive/disruptive behavior in first grade seemed to benefit more, even though the Good Behavior Game had an impact among more aggressive boys in terms of later teenage aggressive behavior.[21] This suggests that better-behaved children in Good Behavior Game classrooms were more able to withstand later exposure to tobacco and peer pressure than were their better-behaved control counterparts or their more aggressive Good Behavior Game classmates. These are issues for examination in follow-up studies involving smokers vs nonsmokers within

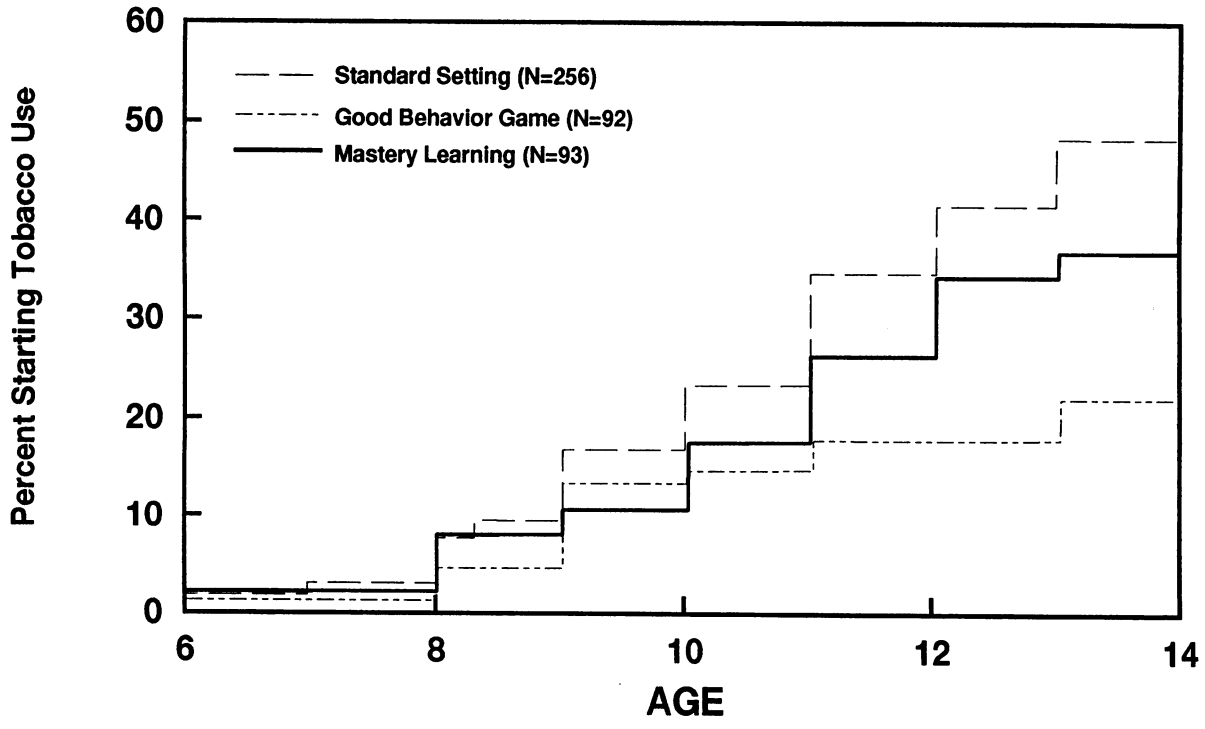

FIGURE 2—Impact of Mastery Learning and Good Behavior Game on boys in first and second grades in terms of initiation of tobacco smoking through 14 years of age: cohort 2.

TABLE 2—Estimated Relative Risk of Initiating Smoking, by Tertile of Aggressive/Disruptive Behavior in First Grade and by Sex: Baltimore Preventive Field Trial, 1985–1994

Designated Subgroup	Intervention/Control Status	Estimated Relative Risk	95% Confidence Interval	*P*
Boys in grade 1				
Lower aggressive/ disruptive (n = 253)	Good Behavior Game (n = 41)	0.13	0.03, 0.62	.011
	Mastery Learning (n = 58)	0.60	0.31, 1.18	.137
	Control (reference) (n = 154)	1.00	. . .	. . .
Middle aggressive/ disruptive (n = 285)	Good Behavior Game (n = 52)	0.82	0.38, 1.77	.618
	Mastery Learning (n = 75)	0.96	0.46, 2.01	.918
	Control (reference) (n = 158)	1.00	. . .	. . .
Higher aggressive/ disruptive (n = 270)	Good Behavior Game (n = 84)	0.57	0.25, 1.28	.172
	Mastery Learning (n = 41)	0.77	0.33, 1.77	.540
	Control (reference) (n = 145)	1.00	. . .	. . .
Girls in grade 1				
Lower aggressive/ disruptive (n = 262)	Good Behavior Game (n = 63)	1.00	0.30, 3.38	.997
	Mastery Learning (n = 51)	1.09	0.57, 2.10	.786
	Control (reference) (n = 148)	1.00	. . .	. . .
Middle aggressive/ disruptive (n = 263)	Good Behavior Game (n = 49)	0.63	0.28, 1.43	.273
	Mastery Learning (n = 67)	2.21	0.78, 6.29	.137
	Control (reference) (n = 147)	1.00	. . .	. . .
Higher aggressive/ disruptive (n = 271)	Good Behavior Game (n = 59)	1.13	0.48, 2.67	.773
	Mastery Learning (n = 60)	1.35	0.60, 3.05	.472
	Control (reference) (n = 152)	1.00	. . .	. . .

Note. Estimates were derived from the conditional form of the Cox proportional hazards model, with risk set stratification by school at entry into first grade.

subgroups defined by sex, early aggressive/disruptive behavior, other mediators and moderators, and intervention assignment.

The Mastery Learning results are important for 2 reasons. The first is the specificity of the Good Behavior Game; if the game's impact was a nonspecific benefit of special attention, then the impact of Mastery Learning should have been comparable to that for the Good Behavior Game. Second, mixed results with respect to Mastery Learning should not lead to dismissal of possible smoking prevention via improving school achievement. In both cohorts, the age 14 cumulative risk estimates for Mastery

Learning boys were intermediate, above levels observed for Good Behavior Game boys but below expected values in control classrooms. In cohort 2, reductions associated with Mastery Learning were statistically significant ($P < .05$). With continued follow-up, these cohorts may show more substantial evidence of Mastery Learning impact.

The Good Behavior Game and Mastery Learning are "universal" interventions received by all children in classrooms, not merely those at higher risk.[33] They are implemented by regular classroom teachers during the regular school day. They are economical in terms of time and money, reducing teacher burden rather than increasing it. In contrast to smoking prevention efforts that focus on the unpleasant or harmful effects of tobacco or promote teenagers' resistance to peer pressure to smoke, the Good Behavior Game targeted a much earlier developmental antecedent for teenage smoking. Our results support a general prevention research strategy of targeting early risk factors as complements to effective interventions in later years. Prevention studies can identify new, potentially malleable developmental antecedents of smoking, later targeting them as antecedents for change.[3,4] □

Acknowledgments

This work was supported primarily by National Institute of Mental Health grants P50MH38725 and R01MH042968 (Sheppard G. Kellam, principal investigator) and by National Institute on Drug Abuse grant R01DA04392 (James C. Anthony, principal investigator).

The contributions of the city of Baltimore, its families and children, and the administration of the Baltimore City Public Schools continue to be enormous. The work of the prevention program would not have been possible without the participation and support of the leadership, faculty, and staff of the school district. Dr Walter Amprey, former superintendent of Baltimore City Public Schools, and former director Dr Juanita Lewis have overseen and guided the current follow-up and the new work on the next stages of intervention development and evaluation. Alice Pinderhughes, former superintendent of the Baltimore City Public Schools, originally worked out the collaborative arrangement with Drs Kellam, Anthony, and other faculty at the Prevention Research Center. The assistance and support of Dr Leonard Wheeler, former assistant superintendent for elementary school, and Dr Carla Ford, former supervisor, Office of Early Childhood Education, have been vital to our program.

The original search for a behavioral intervention to address the social adaptational process between teacher and children was led by Dr Alan Harris, and the implementer and supervisor was Dr Jaylan Turkhan. Dr Lawrence Dolan developed and implemented the Mastery Learning intervention based on the work of Benjamin Bloom and was the first field supervisor. Dr Lisa Werthamer followed Dr Dolan, and she and Dr Nicholas Ialongo have made important contributions. Dr C. Hendricks Brown continues to play a key biostatistical and methodological role. The leadership of Elva Edwards in community base building and crisis backup is gratefully acknowledged. Natalie Keegan produced both the manuscript and the graphic illustrations.

References

1. Anthony JC, Warner LA, Kessler RC. Comparative epidemiology of dependence on tobacco, alcohol, controlled substances, and inhalants: basic findings from the National Comorbidity Survey. *Exp Clin Psychopharmacol.* 1994;2: 244–268.
2. *Prevention of Mental Disorders: A National Research Agenda.* Bethesda, Md: National Institute of Mental Health; 1993.
3. Mrazek PG, Haggerty RJ, eds. *Reducing Risks for Mental Disorders: Frontiers for Preventive Intervention Research.* Washington, DC: National Academy Press; 1994.
4. Kellam SG, Rebok GW. Building developmental and etiological theory through epidemiologically based preventive intervention trials. In: McCord J, Tremblay RE, eds. *Preventing Antisocial Behavior: Interventions From Birth Through Adolescence.* New York, NY: Guilford Press; 1992:162–195.
5. Block J, Block JH, Keyes S. Longitudinally foretelling drug usage in adolescence: early childhood personality and environmental precursors. *Child Dev.* 1988;59:336–355.
6. Ensminger ME, Kellam SG, Rubin BR. School and family origins of delinquency: comparisons by sex. In: Van Dusen KT, Mednick SA, eds. *Prospective Studies of Crime and Delinquency.* Boston, Mass: Kluwer-Nijhoff; 1983:73–97.
7. Farrington DP, Gallagher B, Morley L, St. Ledger RJ, West DJ. Are there successful men from criminogenic backgrounds? *Psychiatry.* 1988;51:116–130.
8. Kellam SG, Brown CH, Rubin BR, Ensminger ME. Paths leading to teenage psychiatric symptoms and substance use: developmental epidemiological studies in Woodlawn. In: Guze SB, Earls FJ, Barrett JE, eds. *Childhood Psychopathology and Development.* New York, NY: Raven Press; 1983:17–55.
9. Robins LN. Sturdy childhood predictors of adult antisocial behavior: replications from longitudinal studies. *Psychol Med.* 1978;8: 611–622.
10. Shedler J, Block J. Adolescent drug use and psychological health: a longitudinal inquiry. *Am Psychol.* 1990;45:612–630.
11. Tomas JM, Vlahov D, Anthony JC. Association between intravenous drug use and early misbehavior. *Drug Alcohol Depend.* 1990;25:79–89.
12. Tremblay RE, Masse B, Perron D, LeBlanc M, Schwartzman AE, Ledingham JE. Early disruptive behavior, poor school achievement, delinquent behavior, and delinquent personality: longitudinal analyses. *J Consult Clin Psychol.* 1992;60:64–72.
13. Kaplan HB, Johnson RJ. Relationships between circumstances surrounding initial drug use and escalation of drug use: moderating effects of gender and early adolescent experiences. In: Glatz MD, Pickens RW, eds. *Vulnerability to Drug Abuse.* Washington, DC: American Psychological Association; 1992.
14. Ialongo N, Edelsohn G, Werthamer-Larsson L, Crockett L, Kellam SG. Are self-reported depressive symptoms in first grade developmentally transient phenomena? A further look. *Dev Psychopathol.* 1993;5:433–457.
15. Kellam SG, Werthamer-Larsson L, Dolan L, et al. Developmental epidemiologically-based preventive trials: baseline modeling of early target behaviors and depressive symptoms. *Am J Community Psychol.* 1991;19:563–584.
16. Barrish HH, Saunders M, Wolf MM. Good Behavior Game: effects of individual contingencies for group consequences on disruptive behavior in a classroom. *J Appl Behav Anal.* 1969;2:119–124.
17. Dolan LJ, Kellam SG, Brown CH, et al. The short-term impact of two classroom-based preventive interventions on aggressive and shy behaviors and poor achievement. *J Appl Dev Psychol.* 1993;14:317–345.
18. Dolan LJ, Turkkan J, Werthamer-Larsson L, Kellam SG. *The Good Behavior Game Training Manual.* Baltimore, Md: Johns Hopkins Prevention Research Center; 1989.
19. Kellam SG, Rebok GW, Mayer LS, Ialongo N, Kalodner CR. Depressive symptoms over first grade and their response to a developmental epidemiologically based preventive trial aimed at improving achievement. *Dev Psychopathol.* 1994;6:463–481.
20. Kellam SG, Mayer LS, Rebok GW, Hawkins WE. Effects of improving achievement on aggressive behavior and of improving aggressive behavior on achievement through two preventive interventions: an investigation of causal paths. In: Dohrenwend B, ed. *Adversity, Stress, and Psychopathology.* New York, NY: Oxford University Press; 1998.
21. Kellam SG, Rebok GW, Ialongo N, Mayer LS. The course and malleability of aggressive behavior from early first grade into middle school: results of a developmental epidemiologically-based preventive trial. *J Child Psychol Psychiatry Allied Disciplines.* 1994;35: 259–281.
22. Kellam SG, Ling X, Merisca R, Brown CH, Ialongo N. The effect of the level of aggression in the first grade classroom on the course and malleability of aggressive behavior into middle school. *Dev Psychopathol.* 1998;10:165–185.
23. Kellam SG, Hunter RC. Prevention begins in first grade. *Principal.* 1990;70:17–19.
24. Chilcoat HD, Dishion TJ, Anthony J. Parent monitoring and the incidence of drug sampling in urban elementary school children. *Am J Epidemiol.* 1995;141:25–31.
25. Kellam SG, Branch JD, Agrawal KC, Ensminger ME. *Mental Health and Going to School: The Woodlawn Program of Assessment, Early Intervention, and Evaluation.* Chicago, Ill: University of Chicago Press; 1975.
26. Werthamer-Larsson L, Kellam SG, Wheeler L. Effect of first-grade classroom environment on child shy behavior, aggressive behavior, and concentration problems. *Am J Community Psychol.* 1991;19:585–602.
27. Chilcoat HD, Anthony JC. Impact of parent monitoring on initiation of drug use through late childhood. *J Am Acad Child Adolesc Psychiatry.* 1996;35:91–100.
28. Lee ET. *Statistical Methods for Survival Data Analysis.* Belmont, Calif: Lifetime Learning Publishers; 1980.

29. *Epidemiological Graphics Estimation Package (EGRET), Analysis Model (PECAN), Version 1.10* [computer program]. Seattle, Wash: Statistics and Epidemiology Research Corporation.
30. Cox DR. Regression models and life tables. *J R Stat Soc Series B*. 1972;34:187–220.
31. Shaffer D, Stokman C, O'Connor PA, et al. Early soft neurological signs and later psychopathological development. Paper presented at: Meeting of the Society for Life History Research in Psychopathology and the Society for the Study of Social Biology, November 1979, New York, NY.
32. Hatch M. What can we infer from findings in subgroups? *Epidemiology*. 1995;6:473–475.
33. Gordon RS. An operational classification of disease prevention. *Public Health Rep*. 1983; 98:107–109.